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Rate of Planting Potatoes With Some Reference to Sprouting Habit and Size of Plants

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CONTENTS

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RATE OF PLANTING POTATOES WITH SOME REFERENCE TO SPROUTING HABIT AND SIZE OF PLANTS

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Since the use of certified seed potatoes has been widely adopted in Ohio, as elsewhere, the seed has become an important factor in the cost of production. The question of the most economical rate of planting has been extensively investigated in the past, but many of the data do not apply to the modern intensive methods and high cost of seed. As a matter of fact, the long established custom of planting 10 to 15 bushels of seed per acre resulted in oversize tubers in many instances in Ohio when heavy fertilization and spraying were adopted. To overcome this, growers adopted closer spacing of hills, which in turn required 20 bushels or more of seed per acre. The experiments reported here were therefore undertaken to throw further light on the most economical size of piece and spacing of hills.

INTRODUCTORY LITERATURE REVIEW

Size of seed piece.—During the early years of the Experiment Stations, numerous experiments on size of seed piece were reported. The majority of these demonstrated an advantage from the use of large seed pieces. Harwood and Holden (7) in summarizing the literature in 1893 listed 95 comparisons of half-tubers with "ordinary two-eye pieces" and showed that in 76 of the 95 experiments the half-tubers gave the higher yield. At that time very little attention was given to the spacing of hills. Apparently, it was customary to plant the hills at least 15 inches apart in the row; and current practices were followed in the experiments.

In 1907 Emerson (6) in Nebraska found that it was more economical of seed to use quarter-tubers 12 inches apart in the row than to use larger pieces at wider spacing. This was confirmed in 1916 by Zavitz (15) in Ontario and recently by Sprague and Evaul (10) in New Jersey. In line with these experiments, closer spacing seems to have been widely adopted in farm practice.

Recent investigators have usually used a spacing of 12 to 16 inches when comparing seed pieces of various sizes. At this closer spacing, large pieces have not been decidedly superior. As a usual rule, in the majority of the experiments the net yields, calculated by deducting the amount of seed from the total yield, have varied

but little with the size of the seed. In other words, the larger seed pieces have given larger yields but the difference has only been sufficient to compensate for the additional seed required. As an illustration, some data from the extended experiments of Stuart, Lombard, Vosbury, Corder, Edmundson, Clark, and Dewey (11) are summarized in Table 1.

TABLE 1.—Average Yield From Cut Seed of Different Weights.*

Yield calculated as bushels per acre of prime potatoes

Weight of seed pieces	Approximate amount of seed planted†	Total prime potatoes	Less the amount of seed	Less twice the amount of seed
Oz.	*Bu.*	*Bu.*	*Bu.*	*Bu.*
1	11	232	221	210
1½	17	247	230	213
2	23	254	231	208
3	34	259	225	191

*Data from Table 12 of Stuart and co-workers (11) summarizing 16 experiments at four diverse points in the United States.

†The spacing varied from 12 to 16 inches between hills in the row during the first two years of the work, but a uniform 16-inch spacing was adopted for the last three years and was the basis in calculating the above averages.

From such results the practical conclusion may be drawn that if seed is cheap, 2-ounce pieces may prove profitable, but if seed is worth more than twice the price per bushel expected from the resulting crop, there is no advantage in using pieces larger than an ounce. Werner (13) came to this conclusion from experiments conducted at North Dakota. A similar conclusion might be drawn from data of Zavitz (15) at Ontario, Emerson (6) at Nebraska, Ballou (3) at Ohio, Rosa (9) at Missouri, Kohler (8) at Minnesota, and Sprague and Evaul (10) at New Jersey. The use of pieces weighing about an ounce appears to be widely adopted as a farm practice thruout the East where certified seed is commonly used. In the West, however, in both irrigated and dry-land sections, the use of larger pieces is common, and according to Tingey and Stewart (12) experimental data justify the practice.

Spacing of hills.—With regard to spacing of hills, the most extensive work is that of Brown (4) at Connecticut, who found that 1-ounce pieces gave the highest net yields when planted 9 to 12 inches apart in the row. He used three varieties and recommended a 9-inch spacing for Irish Cobblers and 12-inch for Russet Rural and Green Mountain. Earlier, Emerson (6) found that in Nebraska the Early Ohio cut into quarter-tubers gave higher net yields spaced 12 inches than when planted either 9 or 18 inches apart in the row. Sprague and Evaul (10) at New Jersey obtained

the highest yield of Green Mountains from a 9-inch spacing which was the closest planting tried by them with ounce pieces. They point out, however, that when net yields were calculated by deducting twice the amount of seed planted, the 12-inch spacing gave practically the same net return as the 9-inch. On the other hand, Werner at North Dakota (13) found very little difference in yield of the Early Ohio over a range of spacings, varying from 6 to 18 inches between hills in the row. A general conclusion from these four reports is that distances of 9 to 12 inches between hills in the row have given higher, or at least as high, net returns from ounce pieces as either wider or closer spacing. This applies to both early and late varieties.

Except for the recent studies of Sprague and Evaul (10), very little work has been done in the eastern states on spacing of seed pieces weighing other than an ounce. They obtained excellent results from ½-ounce pieces when spaced 7½ or 6 inches apart. Their data as a whole show that economical spacing involves the weight of the seed pieces; the smaller the pieces the closer together must the hills be.

Related facts.—In the course of some of the investigations basic facts bearing on the problem have been sought, with the result that the following generalizations are well established and may be listed with little or no comment:

1. Seed pieces weighing less than a half-ounce are too small to produce sturdy plants.

2. The number of plants developing from a seed piece is a function of the weight of the piece instead of the number of eyes. As early as 1892 Arthur (2) emphasized this.

3. The number of plants arising from a seed piece is not directly proportional to the weight of the piece. The smaller the pieces into which the tubers are cut, the larger is the number of plants obtained from a given quantity of seed potatoes.

4. The larger the number of plants per hill the larger is the number of tubers per hill and the smaller is their average size. Since increasing the weight of the seed piece increases the number of plants, it therefore increases the number of tubers and reduces their average size.

5. Close spacing likewise accentuates the competition between plants, reducing the average size of the individual tubers.

6. The use of seed pieces weighing more than 2 ounces or the planting of hills closer than 9 inches in the row has commonly given higher total yields than ordinary planting rates, but with such a large proportion of small tubers as to be impractical.

7. The use of relatively large amounts of seed per acre is more profitable in favorable than in unfavorable seasons. This has not been clearly established but was advanced by Stuart and his co-workers (11) as an explanation of divergent results from season to season in experimental work. The principle is to some extent followed in farm practice by the use of larger amounts of seed on good fields than on poor ones.

SCOPE OF THE EXPERIMENTS

In addition to a series of comparisons of various weight seed pieces at different distances between hills, plantings were made both early and late to determine if the degree of multiple sprouting, described in a preceding bulletin (5), was an important factor.

Special consideration was also given to the minimum size of seed piece which might prove practical. This phase of the problem was emphasized because it was noted that a given quantity of seed potatoes produced more plants when cut small than when cut into large pieces.

WEIGHT OF SEED PIECE AND SPACING OF HILLS

Experimental methods.—A series of comparisons of 1-ounce and 2-ounce pieces at various distances between hills were made during three seasons. The 1-ounce and 2-ounce sizes were selected because they represent the extremes commonly used and recommended. Russet Rural, the dominant late variety of Ohio, was used. Certified seed obtained each fall from Michigan was stored in a basement held as nearly as possible between 35° and 40° F. Immediately prior to planting, the seed was cut into blocky pieces, each weighing within 2 grams of the desired weight. No reference was made to the number of eyes nor to the part of the tuber used, except that each piece had one or more conspicuous eyes.

The field plots were single rows, 25 to 30 feet long. The number of replications varied as noted in the tables of data. Rows were 3 feet apart; this allowed ample room for cultivating and spraying with very little injury to the plants. In current farm practice, the rows are commonly closer, 32 inches being a popular distance. If the rows in the experimental plantings had been closer, there would probably have been larger yields per acre. This statement is based upon the fact that the border rows were not conspicuously superior to the interior rows, indicating that there was but little competition between rows at the distance of 3 feet.

The soil was a Wooster silt loam in a medium state of fertility. This soil type is somewhat heavy for potatoes but is widely used in this district where sandy soils are scarce. No manure was applied. Fertilizer analyzing about 2-12-6 was broadcast at the rate of about 1000 pounds per acre prior to planting. Organic matter was supplied by plowing in soybeans in alternate years. The field was nearly level, and the soil appeared to be uniform in its general character thruout the area used. Excellent stands were obtained. Spraying and cultivation followed current farm practices. The plots were dug by hand, and the tubers sorted over a 1⅞-inch screen to separate those considered as "marketable" from those classed as "small".

Results.—The yields from five comparisons of 1-ounce with 2-ounce pieces are reported in Table 2. The results as a whole are in essential agreement with similar experiments elsewhere. Some of the points of practical interest are as follows:

1. At any uniform spacing of the hills, 2-ounce pieces usually surpassed the 1-ounce in yield of marketable tubers as well as in total yield. But after deducting the seed required from the yield of marketable tubers, there was no consistent superiority of one size of seed over the other. In practical terms, the increases due to the use of the larger pieces were offset by the larger amount of seed required.

2. With either weight pieces closer spacing of hills increased the total yield, but the increase in the proportion of small tubers was so pronounced that in most instances the closest spacing did not give the highest yield of marketable-sized tubers. After deducting the seed required, the highest net yields were in most cases from spacings of 9 or 12 inches between hills, irrespective of the weight of the seed pieces.

3. As shown in the averages at the foot of the table, the highest average net yields were from 1-ounce pieces 9 inches apart, closely followed by the 2-ounce pieces 12 inches apart. However, the averages from the 9-inch and the 12-inch spacing were not significantly different for either size pieces. By referring to the five individual experiments it may be noted that with the smaller pieces, the 9-inch spacing exceeded the 12-inch in net yield only twice; likewise, with the larger pieces the 9-inch spacing was superior to the 12-inch in two experiments. Moreover, in net yields, neither size piece was consistently superior to the other at either the 9- or 12-inch spacing.

TABLE 2.—Yields From 1-ounce and From 2-ounce Seed Pieces at Various Spacing of Hills

Calculated as bushels per acre

Distance between hills	One-ounce seed pieces					Two-ounce seed pieces				
	Seed required	Yield				Seed required	Yield			
In.	Bu.	Total Bu.	Marketable Bu.	Small Bu.	*Net marketable Bu.	Bu.	Total Bu.	Marketable Bu.	Small Bu.	*Net marketable Bu.
Planted April 20, 1926 in duplicate										
3	60	321	258	63	198	120	343	259	84	139
6	30	276	236	40	206	60	323	276	47	216
9	20	265	241	24	221	40	299	272	27	232
12	15	229	207	22	192	30	274	250	24	220
15	12	225	203	22	191	24	252	236	16	212
Planted June 1, 1926 in duplicate										
3	60	201	149	52	89	.....	.....	.....	.....	.....
6	30	179	151	28	121	60	209	178	31	118
9	20	172	157	15	137	40	197	170	27	130
12	15	144	134	10	119	30	168	153	15	123
15	12	149	143	6	131	24	159	149	10	125
18	10	150	141	9	131	20	158	151	7	131
Planted May 23, 1927 in triplicate										
6	30	260	238	22	208	60	261	222	39	162
9	20	246	236	10	216	40	275	259	16	219
12	15	251	241	10	226	30	278	265	13	235
15	12	232	222	10	210	24	255	245	10	221
24	8	183	178	5	170	15	215	207	8	193

TABLE 2.—Yields From 1-ounce and From 2-ounce Seed Pieces at Various Spacing of Hills—Continued

Calculated as bushels per acre

Distance between hills	One-ounce seed pieces					Two-ounce seed pieces				
	Seed required	Yield				Seed required	Yield			
In.	Bu.	Total Bu.	Marketable Bu.	Small Bu.	*Net marketable Bu.	Bu.	Total Bu.	Marketable Bu.	Small Bu.	*Net marketable Bu.
Planted April 21, 1928 in quadruplicate										
6.....	30	279	244	35	214	60	307	236	71	176
9.....	20	259	234	25	214	40	280	239	41	199
12.....	15	248	230	18	215	30	273	236	37	206
Planted June 1, 1928 in duplicate										
6.....	30	265	205	60	175	60	274	198	76	138
9.....	20	248	205	43	185	40	279	215	64	175
12.....	15	238	206	32	191	30	261	212	49	182
Averages										
6.....	30	251.8	214.8	37.0	184.8	60	274.8	222.0	52.8	162.0
9.....	20	238.0	214.6	23.4	194.6	40	266.0	231.0	35.0	191.0
12.....	15	222.0	203.6	18.4	188.6	30	250.8	223.2	27.6	193.2

*Net yields calculated by deducting the amount of seed required to plant an acre from the yield of marketable-sized tubers.,

TABLE 3.—Net Yields Calculated by the Deduction of Twice the Amount of Seed Planted*

Weight of seed pieces	Distance between hills	Yield of marketable potatoes	After deducting seed planted	After deducting twice the seed planted
Oz.	*In.*	*Bu.*	*Bu.*	*Bu.*
1	9	214.6	194.6	174.6
1	12	203.6	188.6	173.6
2	9	231.0	191.0	151.0
2	12	223.2	193.2	163.2

*Summarized from data of Table 2, yields in bushels per acre.

5. The net yields of Table 2 were computed by deducting the bushels of seed required from the yield per acre. In attempting to give a concept of net returns this calculation is open to criticism because seed potatoes are usually worth considerably more per bushel than the resulting crop. It is perhaps more accurate to deduct twice the seed required. If this is done, as in Table 3, the results are decidedly in favor of 1-ounce over 2-ounce pieces.

EFFECT OF DEGREE OF MULTIPLE SPROUTING

The later in the season potatoes are planted the larger is the number of plants arising from each seed piece. In the experiments listed in Table 2, for example, in 1928, the 1-ounce pieces in April averaged 1.24 sprouts per piece; in June they averaged 1.71. Similarly, the 2-ounce pieces produced 1.72 sprouts in April and 2.65 in June. Potatoes were therefore planted both early and late to determine what relation the sprouting habit might bear to the spacing requirements.

TABLE 4.—Comparative Effect of Close Spacing in Early and Late Plantings*

	Weight of seed pieces	Yield of marketable potatoes			Increase in yield	
		12-inch spacing	9-inch spacing	6-inch spacing	9-inch over 12-inch	6-inch over 12-inch
	Oz.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Av. of two April plantings	1	219	238	240	19	21
	2	243	256	256	13	13
Av. of three later plantings	1	194	199	198	5	4
	2	210	215	199	5	-11

*Summarized from data of Table 2.

It seemed reasonable to expect that when seed pieces produced several plants per piece, each hill would require more space for the development of marketable-sized tubers than when each seed piece produced only one or two plants. In other words, close spacing would be more advantageous in April than in June. The data as arrayed in Table 4 confirm to a certain extent this expectation. In

the April plantings the 9- or 6-inch spacing gave higher yields than the 12-inch; whereas in the late plantings the advantage of close spacing was less pronounced. From these results a 9-inch spacing would be preferred for April planting and a 12-inch for plantings of late May or June.

The question was further studied by the use of seed which had been treated with thiourea to induce various degrees of multiple sprouting. Werner (14) reported that thiourea treatment applied to three varieties increased the number of plants per piece and the number of tubers, but had no marked effect on the total yield. He noted, however, that the treated seed gave a larger proportion of small potatoes than the untreated seed, and consequently caused some reduction in the yield of marketable tubers. In some of his plots the pieces were 12 inches in the row, in others 15 inches, but he did not directly study the effect of the spacing.[1]

To obtain as conspicuous effects as possible in a field experiment, seed was used which had been specially handled to preserve apical dominance to a high degree. The seed was cut and part of it soaked in 1% thiourea solution for an hour, another part was soaked for 12 hours. When planted April 1 the untreated pieces produced mostly single sturdy plants, only 14% of the pieces developing two plants. The seeds treated an hour produced an average of nearly two sprouts each; those treated 12 hours, nearly three sprouts.

TABLE 5.—Effect of Increasing the Number of Sprouts per Piece on the Spacing Requirements

Multiple sprouting induced by treatment with 1% thiourea solution*

Treatment	Av. plants per piece	Spacing and yield per acre†		
		12-inch	9-inch	6-inch
Hr.	*No.*	*Bu.*	*Bu.*	*Bu.*
None	1.14	233.4	241.9	260.1
1	1.97	222.2	217.4	223.7
12	2.73	219.1	215.4	178.7

*1-ounce seed pieces.
†Marketable-sized tubers.

The type of sprouting produced by the treatments had a marked effect on the space requirements. The untreated seed increased in yield with the closer spacing of hills while the treated seed did not (Table 5). This is further evidence that the spacing of hills should be adjusted to the degree of multiple sprouting.

Altho specific recommendations can hardly be based upon a single experiment, there is an indication in Table 5 that seed which

[1]Information obtained by correspondence.

is known to be largely in a single-sprout condition could be profitably spaced as close as 6 inches in the row; whereas seed producing two plants or more could not be advantageously planted closer than 12 inches.

In farm practice the chief factor affecting the type of sprouting is the length of time the potatoes are stored (5). It follows, therefore, that the later the crop is planted, the larger will be the number of plants per piece, and the more space each hill will require to produce tubers of marketable size.

MINIMUM WEIGHT OF SEED PIECE

Since it was found that 1-ounce seed pieces gave practically as high yields as 2-ounce pieces and would usually be more economical, the question logically followed: Would pieces smaller than an ounce prove even more economical?

TABLE 6.—Effect of Size of Seed Pieces on the Number of Plants Obtained From a Bushel of Seed Potatoes*

Average weight of seed pieces	Pieces per bushel of seed potatoes†	Average plants per piece	Plants per bushel of seed potatoes
Oz.	*No.*	*No.*	*No.*
½	1920	1.34	2578
1	960	1.76	1690
1½	640	1.95	1248
2	480	2.41	1157

*Calculated from an experiment started May 15, 1929.
†On the assumption that the seed is cut without waste.

In considering the possibilities of small pieces it should be recalled that the smaller the pieces into which a given quantity of seed is cut the larger is the number of plants obtained. As an illustration of this, Table 6 gives the counts from an experiment of 1929. Similar data have been frequently reported, as emphasized in a preceding bulletin (5). If small pieces produced as sturdy plants as larger pieces, it would obviously be economical to cut seed potatoes into single-eye pieces. Experimental results from pieces of various sizes planted at uniform spacing, Zavitz (15), Werner (13), and Kohler (8), have shown a gradual decline in yield from the largest pieces down to about the half-ounce size, then a sudden drop, indicating that pieces smaller than a half-ounce are quite inadequate. But above the half-ounce size the differences in yield might be accounted for on the basis of the number of plants per piece. No measurements of plants were reported in these studies to show that the individual plants from pieces as small as a half-ounce were not as large as those from larger pieces.

Half-ounce pieces.—To compare small and large pieces more accurately the spacing would need to be adjusted so that as many plants were obtained per row (or per acre) from the small as from the large pieces. By spacing the hills 6 or 7½ inches apart in the row, Sprague and Evaul (10) recently obtained as large yields from half-ounce pieces as from larger pieces at wider spacing. On the other hand, Emerson at Nebraska (6) tried 7/12-ounce pieces at a spacing of 6 inches and failed to obtain as high yields as from 1 1/6-ounce pieces spaced 12 inches.

TABLE 7.—One-half-ounce Compared With One-ounce Seed Pieces

Yield of marketable tubers and net yield, in bushels per acre

Distance between hills	One-half-ounce seed pieces		One-ounce seed pieces	
	Total yield	Net yield	Total yield	Net yield
In.	Bu.	Bu.	Bu.	Bu.
Planted April 20, 1926				
3	209	179	258	198
6	195	180	236	206
9	217	207	241	221
Planted June 1, 1926				
3	124	94	149	89
6	119	104	151	121
9	102	92	157	137

At Wooster, half-ounce pieces, spaced closely together in the row, have not given as high yields as ounce pieces properly spaced (Table 7). The plants from the half-ounce pieces were noticeably smaller thruout the growing season.

On the basis of these results at Wooster, seed pieces as small as ½-ounce would not be recommended for general use. Under some special conditions, such as in the increase of seed stock of a new variety, pieces this small might be used to advantage. Sprague and Evaul have emphasized this by stating that the half-ounce pieces give greater returns per bushel of seed than larger pieces. But for ordinary purposes, pieces this size would not be recommended for conditions such as obtain at Wooster.

Three-quarter-ounce pieces.—According to some experimenters ¾-ounce pieces have in some instances given good results; in others they have not. An interesting example is found in the data of Stuart et al. (11), where ¾-ounce pieces were equal to larger pieces in Virginia and Idaho, but were decidedly inferior in Maine. Similarly, Rosa (9) at Missouri in 1919, using two kinds of seed of

Early Ohio, found that 20-gram pieces (approximately ¾ oz.) of home-grown seed were as good as 30-gram pieces, but with northern seed 20-gram pieces were not equal to 30-gram pieces. No explanation was advanced by these workers for the diverging results. Aicher in Idaho (1) failed to get good stands with ¾-ounce pieces. Kohler at Minnesota (8) after testing ¾-ounce pieces recommended the 1-ounce size as the minimum for practical planting. The conclusion to be drawn from such studies is that ¾-ounce pieces cannot be relied upon to give as good results as ounce pieces.

TABLE 8.—Three-quarter-ounce Compared With One-ounce Seed Pieces

Yield of marketable tubers in bushels per acre

Date planted	Yields		Difference in favor of 1-oz. pieces
	¾-oz. pieces	1-oz. pieces	
	Bu.	*Bu.*	*Bu.*
June 17, 1924	315	324	9
April 12, 1927	219	237	18
April 21, 1928*	228	241	13

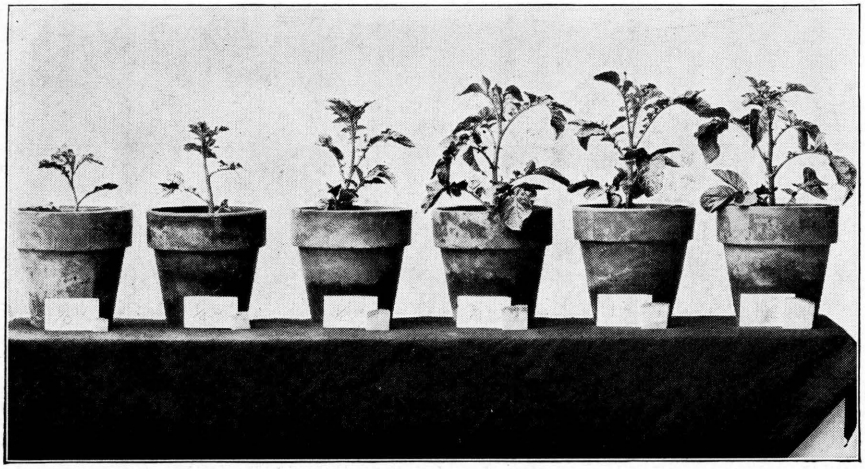
*Thinned to one plant per hill.

Simple comparisons at Wooster of ¾-ounce with ounce pieces at a uniform spacing of 12 inches gave slightly lower yields from the smaller pieces, as shown in Table 8. In the first two comparisons the difference in yield might be attributed to the larger number of plants per hill from the ounce pieces, but in 1928 the hills were thinned to single plants as a means of eliminating this factor. In this last test the difference was 13 bushels per acre in favor of the ounce pieces. Thirteen bushels was too small a difference to be conclusive evidence that the plants from three-quarter-ounce pieces were not as strong as from the ounce pieces, but nevertheless does suggest a small difference.

MEASUREMENTS OF SIZE OF PLANTS

Thruout the course of these experiments it was noticed that seed pieces weighing a half ounce or less did not produce as large plants as pieces weighing an ounce or more. A typical illustration from a greenhouse experiment is given in Figure 1. At this planting the seed was highly apically dominant, each piece producing but one sprout. The photograph shows that the plants from the three larger pieces were practically the same size; whereas those from the three smaller pieces progressively decreased. It appeared

from such observations that ¾-ounce pieces could support as sturdy plants as larger pieces. These were simply observations, however, and not critical measurements.



⅛ oz. ¼ oz. ½ oz. ¾ oz. 1 oz. 1½ oz.

Fig. 1.—Sprouts from seed pieces of different size, planted in greenhouse in February

To obtain more accurate data on the relation of size of piece to size of plants, with particular reference to the minimum size for practical planting, pieces varying from ½ ounce to 2 ounces were planted in the field in May 1929. Attempts to measure the resulting plants in the row were not satisfactory; hence, the entire planting was dug July 1, when the plants were about 30 centimeters high, and spread upon a table for measurement. Plants which were stunted because of rotting of the seed piece were discarded. The remaining plants were measured to within ½ centimeter. As many of the pieces had given rise to two or three plants, two classes were made, the largest plant from each piece being arbitrarily designated as the "primary", the others as "secondary".

The measurements of 1929 are summarized in Table 9. A first point of interest in this table is the comparison of 1-ounce with larger pieces. The primary sprouts from the ounce pieces averaged only ½ centimeter smaller than those of the 2-ounce pieces. This difference was so small as to be barely measurable; and statistical treatment of the four replications gave odds of only 11 to 1 that the difference was actually due to the difference in weight of the seed pieces. The really significant difference between 1-ounce

and 2-ounce pieces was in the number and size of the secondaries. Not only were there more secondaries from the larger pieces, but they averaged 2 centimeters longer (Fig. 2).

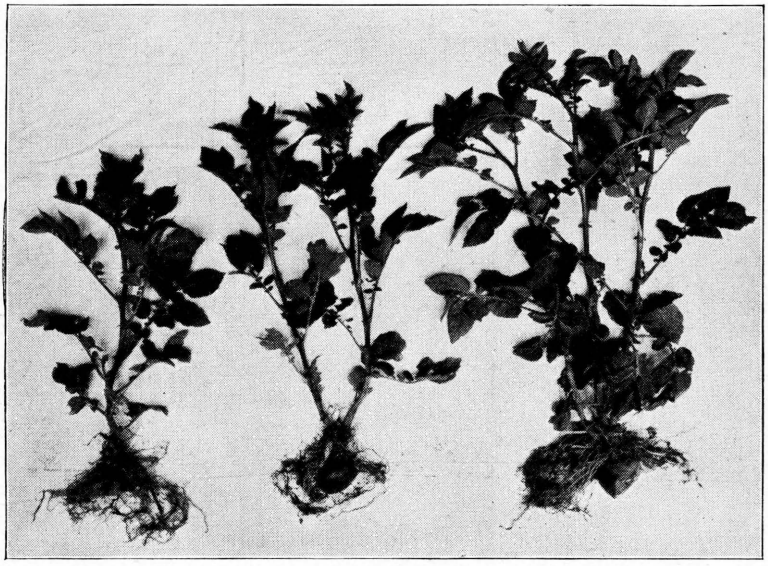


Fig. 2.—Typical difference in vigor of plants from ½-ounce, ¾-ounce, and 2-ounce pieces. From field planting of May 15, 1929

A second point of interest is the comparison of ¾-ounce and 1-ounce pieces. As in previous years, no obvious difference in the size of the plants was noted as they grew in the row, but when this set was laid upon a table, difference was readily discerned. The primaries from the ounce pieces averaged 2.5 centimeters longer than those from the ¾-ounce.

TABLE 9.—Average Length of Plants From Seed Pieces of Various Weights

Weight of seed pieces	Primary plants		Secondary plants		All plants	
Oz.	Number	Length Cm.	Number	Length Cm.	Number	Length Cm.
1929						
½	71	30.6	24	26.7	95	29.6
¾	73	32.9	40	28.3	113	31.4
1	66	35.9	50	29.7	116	33.1
1½	65	36.2	62	31.6	127	33.9
2	68	36.3	97	32.1	165	33.8
1930						
¾	36	32.5	11	27.2	47	31.3
1	43	34.6	29	29.9	72	32.7
1½	38	34.1	49	30.8	87	32.3

In the experiments repeated in 1930, the results were essentially the same, as shown in Table 9. Again the primary plants from the ¾-ounce pieces were about 2 centimeters shorter than those from the ounce pieces.

This difference of 2 centimeters in the early growth of the plants would seem sufficient to preclude the use of ¾-ounce pieces for practical planting. The measurements explain and confirm the 1929 results (p. 12) which indicated that ¾-ounce pieces thinned to one plant did not give as high yields as ounce pieces similarly thinned.

Fig. 3.—Typical difference in size of plants from ¾-ounce and 1-ounce seed pieces, 1930

Bordeaux spray shows as a white coating on some of the leaves

On the other hand, the difference between 1-ounce and larger pieces lay so largely in the vigor of the secondaries that by themselves these measurements can hardly serve as a basis for recommendations. Rather they explain the yields as reported in Table 2 and support the practical conclusions deduced from those data.

PRACTICAL RECOMMENDATIONS

From the results at hand, seed pieces weighing about an ounce each are recommended. There are special circumstances, however, where smaller or larger pieces may be advantageous: (1) If seed were very cheap, pieces as large as 2 ounces would be profitable; (2) If seed were peculiarly valuable so that the yield per acre was secondary to the yield per bushel of seed, as for example, in the propagation of a rare variety, half-ounce pieces would be advocated. But for most conditions ounce pieces are recommended as the most economical size.

On fields of moderate fertility, such as those of the present experiments, spacing the hills 9 to 12 inches apart in the row is recommended. If a late variety, such as the Russet Rural, is

planted in April or early May, the closer spacing is to be preferred, but if planting is delayed until late May or June a 12-inch spacing is preferred.

In present day farm practice more seed is commonly sown on fertile fields than on poor fields. Similarly, the rate of planting is relatively high in regions where the climate is peculiarly favorable for potatoes. These variations in planting rates are based upon the reasonable assumption that more tubers per acre may be expected to attain marketable size under favorable than under unfavorable growth conditions, and upon the fact that the number of tubers is, to a degree, proportional to the amount of seed planted. In this connection it should be noted that an increase in number of plants per acre is more economically attained by decreasing the distance between hills than by increasing the size of the seed pieces.

In attempting to follow the above recommendation of ounce pieces, growers realize that in practice the pieces cannot be cut to a uniform size and the average weight will probably be something above an ounce. As an aid in estimating the amount of seed required per acre, the following table therefore gives the computation for 1-ounce and for 1¼-ounce pieces.

TABLE 10.—Bushels of Seed Required to Plant an Acre

Spacing of hills	Average weight of seed pieces	
	1 ounce	1¼ ounce
	Bu.	*Bu.*
Rows 36 inches apart:		
12 inches in row	15.1	18.9
9 inches in row	20.1	25.2
Rows 32 inches apart:		
12 inches in row	17.0	21.3
9 inches in row	22.6	28.4

SUMMARY

Seed pieces of Russet Rural were cut individually to weight and planted at various distances in a Wooster silt loam of medium fertility.

Spacing the hills 9 or 12 inches apart in the row gave higher yields of marketable-sized potatoes than either wider or closer spacing.

Two-ounce seed pieces gave higher yields than 1-ounce pieces at the same spacing, but the difference was only sufficient to compensate for the larger amount of seed required. In other words, the net yields, calculated by deducting the amount of seed required, were essentially the same from 1-ounce and 2-ounce pieces.

Since seed pieces of a given size produce more sprouts when planted late than when planted early, spacing experiments were started in April and repeated about 6 weeks later. Close spacing in the row, that is, 9 inches or less, was more advantageous in early than in the later plantings. Similar results were obtained from seed in which different degrees of multiple sprouting were induced by thiourea treatments: the larger the number of sprouts per piece the more space each hill required to develop its tubers to marketable size.

Measurements of plants from various size pieces showed that ounce pieces produced larger plants than half-ounce or ¾-ounce. The plants from 2-ounce pieces were slightly larger than those from ounce pieces, but when the measurements were restricted to the largest single plant from each piece the difference was not significant. The chief distinction between 1-ounce and 2-ounce pieces was in the greater number of plants from the larger piece. The number of plants, however, was not directly proportional to the weight of the piece, so that more plants were obtained from a given quantity of seed tubers by cutting them into ounce pieces than into 2-ounce pieces.

The recommended economical procedure in planting is, therefore, to use pieces weighing about an ounce each, spacing the hills 9 to 12 inches apart in the row.

LITERATURE CITED

1. Aicher, L. C. Experiments in the size of the seed piece and other factors in the production of potatoes under irrigation in southern Idaho. Idaho Agr. Exp. Sta. Bull. 121, 1920.
2. Arthur, J. C. The potato: Relation of the number of eyes on the seed tuber to the product. Ind. Agr. Exp. Sta. Bull. 42, 1892.
3. Ballou, F. H. The status of the potato growing industry in Ohio. Ohio Agr. Exp. Sta. Bull. 218, 1910.
4. Brown, B. A. Spacing of potato hills. Conn. Agr. Exp. Sta. Bull. 119, 1924.
5. Bushnell, John. Normal multiple sprouting of seed potatoes. Ohio Agr. Exp. Sta. Bull. 430, 1929.
6. Emerson, R. A. Potato experiments. Neb. Agr. Exp. Sta. Bull. 97, 1907.
7. Harwood, P. M. and P. G. Holden. Potatoes. Amounts of seed. Mich. Agr. Exp. Sta. Bull. 93, 1893.
8. Kohler, A. R. Potato experiments and studies at University Farm in 1909. Minn. Agr. Exp. Sta. Bull. 118, 1910.
9. Rosa, J. T. Seed studies with Irish potatoes. Mo. Agr. Exp. Sta. Bull. 191, 1922.
10. Sprague, H. B. and E. E. Evaul. Effect of size of seed piece and rate of planting on yields of white potatoes. Jour. Am. Soc. Agron. 21: 513-523, 1929.
11. Stuart, W., P. M. Lombard, M. C. Vosburg, G. Corder, W. C. Edmundson, C. F. Clark, and G. W. Dewey. Size of potato sets; comparisons of whole and cut seed. U. S. Dept. Agr. Bull. 1248, 1924
12. Tingey, D. C. and G. Stewart. Effect of size of seed set on yield and on certain other characters in potatoes. Jour. Amer. Soc. Agron. 20: 710-721, 1928.
13. Werner, H. O. Potato experiments, 1917 and 1918. N. Dak. Agr. Exp. Sta. Bull. 129, 1919.
14. Werner, H. O. The use of thiourea for controlling tuber size of potatoes. Proc. Potato Ass'n. Amer. 15:88-100, 1928.
15. Zavitz, C. A. Potatoes. Ont. Dept. Agr. Bull. 239, 1916.

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